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Diagnostic Yield from 231 Autopsies in a Community Hospital

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Autopsy reports of 231 adult autopsies were examined for clinically unexpected diagnoses. Analysis of data showed that 97 of 188 autopsy diagnoses were clinically unexpected. The diagnosis of pulmonary embolism was clinically the most frequently missed diagnosis relative to its actual occurrence. Also noted was that the proportion of cases with unexpected diagnoses increased from 1983 to 1987. (Key words: Autopsy; Unexpected diagnosis; Pulmonary embolism) Am J Clin Pathol 1990;93:486–490

THE NEED for more autopsies has received much attention recently, especially in light of the fact that the autopsy rate has been shown to be declining steadily over a period of decades.[1,2] A number of factors[2,4,6,12] have been implicated in the downward trend of hospital autopsy rates, including elimination of a minimum autopsy rate for hospitals by the Joint Commission on the Accreditation of Hospitals and the notion among many clinicians that autopsies provide no new information regarding the patient or disease process in general.

Despite the reasons given for the downward trend in the autopsy rate, several studies[6,7,9–11,13] have shown that the autopsy is useful as a quality control, not only for clinical diagnosis, but also for treatment because autopsies serve to measure the accuracy of diagnostic techniques as well as the effectiveness of therapy, whether medical or surgical, and any side effects of such therapy.

In addition to information provided by individual autopsies, data from large numbers of autopsies may be compiled to provide autopsy statistics that are useful in epidemiologic studies.[8] Autopsy findings, especially when used with clinical correlation, can provide a much better indication of the cause of death than the death certificate,[9] which often does not concur with the autopsy as to the cause of death. The same holds true for hospital medical records. Findings at autopsy frequently are clinically unexpected,[11] and, although clinical diagnostic techniques have substantially improved the ability to correctly identify disease processes, the autopsy remains the final means of detecting anatomic changes. These facts are important because death certificates and hospital records are often used as the sources of morbidity and mortality statistics.[5,8]

The present study concentrates only on the ability of hospital records to help predict findings at postmortem examination. Specifically, the purpose of this study is to determine the extent of occurrence of unexpected findings at autopsy by comparing autopsy findings with clinical abstracts prepared from hospital records.

Materials and Methods

Monmouth Medical Center, the institution where this study was performed, is a 525-bed voluntary community hospital. It serves more than a half million people in New Jersey and provides general, special, and regional care facilities, including medical, surgical, and pediatric intensive care units, physical and pulmonary medicine laboratories, and renal dialysis and radiotherapy departments.

Autopsies selected for inclusion in this study consisted of autopsies performed at Monmouth Medical Center during the years 1983–1987. The total number of autopsies during this period was 419. Of these, 168 were were excluded because they did not meet the minimum age requirement, which was 18 years. The minimum age of 18 years was established for the purpose of limiting the study population to those cases in which patients would have adult-type diseases.

Thirteen cases were excluded because the patients were either dead on arrival to Monmouth Medical Center or had died elsewhere and were brought to this hospital solely for the purpose of postmortem examination. In such cases, clinicians at Monmouth Medical Center probably would not have had an opportunity to provide a proper clinical diagnosis for comparison with the postmortem diagnosis.

An additional four cases were excluded from the autopsy population because the autopsy reports were incomplete at the time of data collection. The incomplete autopsy reports either had no Final Anatomic Diagnosis or had a Final Anatomic Diagnosis in the process of being written or signed out by the attending pathologist. The reports of two more cases could not be located, and the report of one case (liver biopsy only) had no attached clinical history. The final study population consisted of 231 cases.

Records reviewed for data collection were the autopsy reports, with the main emphasis being on the Final An-

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atomic Diagnosis, the Provisional Anatomic Diagnosis, and the Clinical Abstract. The Final Anatomic Diagnosis revealed all positive findings and relevant negative findings detected by the postmortem examination, including gross findings, histologic findings, and relevant microbiologic findings. The Provisional Anatomic Diagnosis contained gross findings and clinical diagnosis. Both the Final Diagnosis and Provisional Diagnosis contained patients' demographic characteristics. The Clinical Abstract was a summary of the patients' clinical history with hospitalization. Other portions of the autopsy reports were examined when clarification was required about postmortem findings.

The autopsy diagnoses were taken from the Final Anatomic Diagnosis and were compared with the clinical diagnoses found in the Clinical Abstract and Provisional Anatomic Diagnosis portions of the autopsy reports. Depending on whether or not the diagnosis made at autopsy was contained in the clinical diagnosis, the anatomic diagnosis was classified as unexpected or expected.

Diagnoses confirmed at autopsy that were not specifically mentioned in the clinical abstract but for which sufficient criteria existed in the form of clinical and laboratory findings were classified as expected.

All diseases included as either expected or unexpected should have been severe enough to have probably caused the death of the patient as judged from the autopsy report. Thus, severe terminal events as well as other severe conditions that would have otherwise caused the death of the patient in the near future were included. For example, in a patient with widely metastatic carcinoma who died of massive pulmonary embolism, both the carcinoma and pulmonary embolism would be included in the study. If the severity of the condition could not be gauged from the Final Anatomic Diagnosis, other sections of the autopsy report were reviewed. No diagnosis was included in which the severity of the condition could not be inferred.

Data were also collected on age, sex, race, completeness authorized for each autopsy, and duration of hospitalization of the patient at Monmouth Medical Center. Patients who entered Monmouth Medical Center through the emergency room and died there or who were admitted as inpatients but who lived for less than one day were recorded as being hospitalized for one day.

The entire set of autopsy reports was reviewed twice for examination of wording of the Final and Provisional Anatomic Diagnosis and Clinical Abstract in order to formulate definitions for categorization of data. On formulation of the definitions, the entire set of autopsy reports was again reviewed twice for data collection and categorization.

The data were analyzed with the use of the following: (1) the Pearson chi-square test[14] for detecting whether significant difference existed within a given set of unexpected diagnoses classified into disease categories; (2) Bartholomew's test,[3] for detecting trends over the five-year period; and (3) the odds ratio with a 95% confidence interval,[3,8] for determining magnitude of difference between categories.

Results

The average age of the study population was 65.7 years (SD = 15.1 years), and the age range was 19–93 years. In 53.2% of cases the patients were males and 87.8% of cases white. The department of medicine submitted 87.2% of the cases for autopsy, with the remaining cases being submitted by the departments of surgery, orthopedics, and radiation therapy. One hundred fifty-eight cases (68.9%) were complete autopsies, with 73 cases (32.1%) having some restriction such as follows:

1. No examination of brain,
2. Examination of heart and lungs only,
3. Examination of lungs only,
4. Examination of heart only,
5. Examination of abdomen only,
6. Examination of brain only,
7. *In situ* examination only, with biopsies, and
8. Liver biopsy only.

(Note: the strict definition of the term "biopsy" requires that the tissue be from a living body, but "biopsy" here refers to tissue removed at autopsy.)

The average duration of hospitalization for a patient submitted for autopsy was 20.7 days (SD = 26.5 days).

There was a total of 285 diagnoses, with 97 being clinically unexpected. All diagnoses were classified into one of nine categories, with the most frequent causes of death being cancer (77 cases) and infection (61 cases). Analysis with the chi-square test showed that there was a significant difference (Table 1, $P < 0.025$) in the set of expected and

Table 1. Unexpected Diagnoses Divided into Disease Categories

Disease Category	Total	Number Unexpected (%)	Odds Ratio	95% Confidence Interval
Infection*	61	18 (29.5%)	1.00	(reference)
Cancer*	77	19 (24.7%)	0.78	0.37–1.66
Pulmonary embolism	18	11 (61.1%)	3.75	1.25–11.23
Myocardial infarction	34	11 (32.4%)	1.14	0.46–2.82
Other cardiovascular	15	8 (53.3%)	2.73	0.86–8.66
Gastrointestinal†	28	13 (46.4%)	2.07	0.82–5.22
Pulmonary	11	6 (54.5%)	2.87	0.77–10.61
Central nervous system	18	7 (38.9%)	1.52	0.51–4.55
Other	23	4 (17.4%)	0.50	0.15–1.69

Pulmonary diseases exclude pulmonary embolism.

* Infection and cancer are included under separate headings and are not included under other individual categories.

† Gastrointestinal diseases include ulcer penetration and perforation, intestinal infarction, and obstruction.

Table 2. Disease Categories by Year

1983	
Infection	OOOOOOOOXXXXX
Cancer	OOOOOOOOOOOOOOXXX
Pulmonary embolism	OXXX
Myocardial infarction	OOOOOOX
Other cardiovascular	OOOOOXX
Gastrointestinal	OOOXX
Pulmonary	
Central nervous system	OOOOX
Other	OOOOOOOX
1984	
Infection	OOOOOOOOOOOXXXXXX
Cancer	OOOOOOOOOOOOOOOXXXXXXX
Pulmonary embolism	OXXXXX
Myocardial infarction	OOOXXXX
Other cardiovascular	OXX
Gastrointestinal	OOOXX
Pulmonary	X
Central nervous system	OOXX
Other	OOOO
1985	
Infection	OOOOOOOOXXX
Cancer	OOOOOOOOOOXX
Pulmonary embolism	OOOX
Myocardial infarction	OOOOXX
Other cardiovascular	X
Gastrointestinal	OOOXX
Pulmonary	O
Central nervous system	OOX
Other	OOX
1986	
Infection	OOOOOOOOOOOOXX
Cancer	OOOOOOOOXXXXX
Pulmonary embolism	OX
Myocardial infarction	OOO
Other cardiovascular	XX
Gastrointestinal	OOX
Pulmonary	OX
Central nervous system	O
Other	OOOXX
1987	
Infection	OOOOXX
Cancer	OOOOOOOOOOOXX
Pulmonary embolism	OX
Myocardial infarction	OOOOOOOXXXX
Other cardiovascular	OX
Gastrointestinal	OOOOXXXXXX
Pulmonary	OOOXXXX
Central nervous system	OOXXX
Other	OOO

O = expected diagnosis; X = unexpected diagnosis.

unexpected diagnoses. On calculation of the odds ratios of each category with the use of the infection category as the reference group (the reason for which is given later), only the category of pulmonary embolism was found to be significantly different, with the odds of pulmonary embolism being found unexpectedly to be nearly four times the odds for infection found unexpectedly.

When the disease categories were divided by year and similarly compared with the infection category of the respective year, no significant results were obtained, probably because of decreased power of the test as a result of the small number of cases in each division. The categories divided by year are provided for visual comparison in Table 2.

When unexpected and expected diagnoses were categorized by year instead of disease category, isotonic regression revealed no significant trend, and no significant odds ratios (relative to 1983) were detected. Significance also was not detected when odds ratios were calculated for the yearly division of each disease category relative to the respective disease division of 1983.

Individual patients were then classified depending on whether they had only expected or any unexpected diagnoses. The patients were then categorized by year and analyzed by isotonic regression. No significant trend was found, with the proportion of patients with unexpected diagnoses showing no gradual change with each year (Table 3). The odds ratio showed that the odds of a patient having an unexpected diagnosis in 1987 were more than twice that in 1983. The odds ratios for the remaining years relative to 1983 were not significant.

Discussion

The total number of autopsies included in this study was within the range of those included in other studies[6,7,9,11] that examined 100–300 autopsies, although not all of these studies were similarly performed. The average age and sex distribution[6,9,11] varied in other studies: from 54 to 71 years for the average age and 49 to 55% male for the sex distribution, which generally agrees with the findings in this study. However, Ahronheim and colleagues[1] claim that very few autopsies are done in the elderly population and that most autopsies are on those in the third decade of life. Only one study referred to race,[9] stating that 95% of patients were white, which is

Table 3. Autopsies with One or More Unexpected Findings by Year

Year	Total Autopsies	Autopsies (%) (unexpected findings)	Odds Ratio	95% Confidence Interval
1983	56	16 (28.6%)	1.00	(reference)
1984	58	25 (43.1%)	1.89	0.87–4.12
1985	39	11 (28.2%)	0.98	0.40–2.43
1986	37	14 (37.8%)	1.52	0.63–3.67
1987	41	20 (48.8%)	2.38	1.02–5.53

slightly more than the frequency at Monmouth Medical Center. The average duration of hospitalization in the studies reviewed[6,11] varied from 13 to 23 days. In one study[6] the percentage of autopsies from the medical service was 63% *versus* 37% from surgical, and authorization for complete examination was 82%.

The disease categories were based on the classification used by Landefeld and associates.[11] Infections and malignancies were separately categorized from the organ systems because infections and malignancies are frequently not localized to a single organ system. All organ systems listed subsequently did not include infections or malignancies, even if they were localized. Pulmonary embolism and myocardial infarction were separated from other cardiovascular disorders, such as atherosclerosis and thrombosis, collagen–vascular disease, and aneurysm, because pulmonary embolism and myocardial infarction form a large majority of the cardiovascular disorders and statistical significance might have been diminished by their inclusion with the less common cardiovascular disorders. Gastrointestinal diseases leading to death included peptic ulcers with penetration or perforation, bowel infarction (noted separately from cardiovascular disorders because these events present with gastrointestinal symptoms), and obstruction (including tumor and fecal impaction). Fatal pulmonary disease included aspiration and collapse as the most common entities. Fatal central nervous system diseases included cerebrovascular events and multiple sclerosis. The category of "other" included renal, hepatic, and metabolic disorders that individually constituted very small numbers.

Analysis of missed diagnosis as shown by autopsy in general shows similar results in different studies,[6,9,11,13] the most common unexpected findings being infection, pulmonary embolism, and myocardial infarction. In the present study it was pulmonary embolism that was most often missed. Because infection was the most commonly missed diagnosis in the series studied by Landefeld and associates,[11] this was chosen as the reference when calculating the odds ratios for unexpected diagnoses. Examining the actual number of missed diagnoses in this study and comparing these numbers with those in the previously cited references shows that this institution shows a large absolute number of unexpected diagnoses; the other studies show mainly single-digit figures for unexpected diagnoses, whereas the series from this hospital shows many double-digit figures. However, it should be kept in mind that the present autopsy study includes adult autopsies done over a five-year period, whereas the other studies included a similar number of autopsies from a shorter time span. This may mean that Monmouth Medical Center has a much lower autopsy rate than other institutions, with autopsies of only selected, diagnostically difficult cases, thus increasing the probability of unexpected diagnoses.

The selection of cases may also be responsible for the greater proportion of unexpected diagnoses in 1987 as compared with 1983, although this is doubted by Goldman and colleagues.[6] Their study showed no significant difference between the occurrence of missed diagnoses in 1960, 1970, and 1980.

Errors in data classification[8] may have introduced more serious problems in the results. Nondifferential misclassification (errors in classification in which cases were assigned to the wrong category without a systematic bias favoring any particular category) would tend to attenuate the magnitude of the odds ratio. This would have occurred mainly during review of the autopsy reports, whereby diagnoses would mistakenly be classified randomly in the wrong classification of expected/unexpected. More serious would be differential misclassification errors (errors in classification in which cases were assigned to the wrong category with a systematic bias favoring a particular category), which would not only be capable of attenuating the magnitude of the odds ratio, but also magnifying the odds ratio. This type of misclassification could have occurred either during writing of the medical records or during summarization of the medical records for preparation of the clinical abstract. During these stages, transient or terminal clinical events such as pulmonary embolism may have been selectively excluded from the clinical diagnosis because of negligence in recording information. This would have caused such events to be classified more often as unexpected. Differential misclassification could also have occurred during review of the autopsy reports if a bias was present when assigning cases or diagnoses to certain categories.

Mention also needs to be made about the degree of stratification used in this study during analysis of significance. Because the cases available were stratified into numerous categories, producing very small numbers of cases in each category, the power of any statistical test to detect a real difference between categories would be diminished. Thus, even if a number of trends were present, they would not be detected.

Finally, this study was done mainly as a descriptive cross-sectional study with relatively little analysis of associations between different factors. Associations between the unexpectedness of diagnoses and between unexpected diagnosis and year of autopsy were analyzed, but other patient characteristics such as sex, race, and other disease processes were not taken into account as confounding factors. However, the statistical analysis did show a significantly high occurrence of unexpected pulmonary embolism, as well as an increase in the proportion of unexpected diagnoses in 1987 as compared with 1983.

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